COFERMENTATION OF ORGANIC WASTE OF THE PILOT FARM OF SZTE MGK

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ABSTRACT

The exploitation of the actual capability of renewable energy sources can run with the choosing the most perfect utilization territory and taking the fitting technical solutions to the demand of utilization. By the planning of a biogas plant at a smaller, bigger, heavily environment polluted agricultural territory it is necessary to make experiments, measurements if it is possible in industrial size in the goal of successful operation. The experiments proved the entitling energy aimed anaerobic treatment of the organic waste at the pilot farm. The results of experiments are a little bit far from the values in the literature, because the releasing of gas the most intensive after the stabilization, and because the manure is not the freshest, the gas production can be extremely smaller because of the evaporation and resting of the manure. In my experiments there can be high pressure problems when there is no perfect gas removing, which is can destroy the instruments.
Keywords: environmental protection, sustainable agriculture, cofermentation, organic waste, energy production from agricultural byproducts.

1. INTRODUCTION

The importance of waste treatment is extremely increasing, because of the environmental aims are the main driving force. The stricter regulations for land filling will to lead to the development of alternative treatment methods for waste management. For the agro-mechanical research, animal rearing's and food-industry's waste material, the secondary-tertiary biomass, is a highest concern. This technology is versatile and relatively simple to use as a reliable and effective means of producing a gaseous fuel from various organic waste. The most common application has been the digestion of animal dung, agricultural, and food-industrial waste. This was studied by our Institute in our pilot farm of our Faculty. The 50 dairy cow, family sized modelfarm was built in the summer of 1991 as a result of □olland – Hungarian cooperation at the territory of the Faculty. The new pigfarm with 30 sows and the new goatfarm with 100 nannies were given to the Faculty on the 25^{th} of April of 2001. Trough the livestock data the annual dung production were specified and calculated the energy by the biogas production coefficients in my formal reports. I want to find solution by the cofermentation of the organic waste, for example: pig manure, cattle manure, waste water of cheese factory, milking parlour to treat the dangerous materials attached with the energy production.

2 METHODS AND MATERIALS

The experimental laboratory was established in the SZTE MGK's formally social rooms: in one bath room and in one dressing room with 4 vertical fermentors filling every requirements of the perfect operation. The composition of the substratum models the content of the daily production of the organic waste. The quantity of the different type of waste water is measured, the mass of the manures is calculated by the literary data in the 1. chart FENYVESI-MÁTYÁS (2001). Trough the experiments we can construct the best formula concerned with the highest gas production. The pilot farm has beyond the mentioned waste materials manure from ships, poultry, ostrich, and from the primary plant production: winter wheat, maize, sunflower, □ucerne, hay, but the utilization depends on especially the type of the manure, the technology of the dung removal. The utilization of the ship manure is solved, the poultry dung contents floating and residual elements, which can cause problems through the fermentation. That's why I chose the pig manure and the cattle dung to use energetically. To produce energy from the plants is another question, which is not the topic of this paper.

Table 1. The calculation of the organic waste produced by the SZTE MGK pilot farm

	Number of animals	Dung production/ Day (kg/d*peace)	Total organic waste (t/d)
Cattle	47	46	3,7
Pigs	22	15	2,1
Waste water of creamery			6
Waste water of milking parlour			1
Total			12,8

Table 2.: The animal originated organic biomass quality in the substratum and the possible gas yield from this waste

The components of the substrate	Weight (kg)	DMC (%)	DMC (kg)	OMC /DMC. (%)	OMC (%)	OMC (kg)	Theoretical gas yield (l/d)
Cattle dung	14,5	21,32	3,09	60,68	12,94	1,88	375 *
Pig manure	8,2	22,49	1,84	71,40	16,06	1,32	586 **
Waste water of creamery	23,4	0,08	0,0187	51,25	0,0410	0,0096	0
Waste water of milking parlour	3,9	0,15	0,0059	40,00	0,06	0,0023	0
Total:	50	9,92	4,96	64,62	6,41	3,21	961

Dry matter content = DMC; Organic matter content –OMC; *200 l/kg OM;**445 l/kg OM.

Table 3.: Determination of the dry matter content of different straw manures

	Pig sample weight (g) I.	Pig sample weight (g) II:	Pig sample weight (g) III.	Pig sample weight (g) IV.	Mean	Cattle sample weight (g) I.	Cattle sample weight (g) II.	Mean
Tara	315,05	306,2	70,56	323,2		113,01	163,6	
Brutto wet sample weight	421,07	686,8	531,46	701,1		419,2	683,8	
Brutto dry sample weight	340,46	387,8	169,2	410,6		180,59	270,6	
Netto wet sample weight	106,02	380,6	460,9	377,9		306,19	520,2	
Netto dry sample weight	25,41	81,6	98,64	87,4		67,58	107	
DMC (%)	23,97	21,44	21,40	23,13	22,49	22,07	20,57	21,32

Dry matter content = DMC; Organic matter content –OMC;

Table 4.: Determination of the organic matter content of different straw manures

Pig								Mean
Tara(g)	68,44	67,87	67,5	23,36	71,03	67,35	376,7	
Brutto dry sample weight (g)	83,21	88,71	95,42	25,1	96,05	138,73	457,6	
Netto dry weight (g)	14,77	20,84	27,92	1,74	25,02	71,38	80,9	
Brutto inorg. Residue (g)	71,75	73,44	74,8	23,92	79,13	90	403,7	
Netto inorg. Residue (g)	3,31	5,57	7,3	0,56	8,1	22,65	27	
Org. matter weight (g)	11,46	15,27	20,62	1,18	16,92	48,73	53,9	
OMC/DMC. (%)	77,59	73,27	73,85	67,82	67,63	68,27	66,63	71,40

Dry matter content = DMC; Organic matter content –OMC;

Table 5.: Determination of the organic matter content of different straw manures

Cattle							Mean
Tara(g)	68,03	67,36	67,33	51,1	51,15	51,15	
Brutto dry sample weight (g)	105,48	120,58	107,97	55,36	59,88	56,51	
Netto dry sample weight (g)	37,45	53,22	40,64	4,26	8,73	5,36	
Brutto inorg. Residue (g)	81,97	86,44	82,53	52,76	54,48	53,34	
Netto inorg. Residue (g)	13,94	19,08	15,2	1,66	3,33	2,19	
Org. matter weight (g)	23,51	34,14	25,44	2,6	5,4	3,17	
OMC/DMC. (%)	62,78	64,15	62,60	61,03	61,86	59,14	60,68

Dry matter content = DMC; Organic matter content –OMC;

To measure the dry matter content I heated the straw manure till mass permanence in 105 °C in the case of more relatively big mass of sample. I determined the organic matter ratio compared the dry matter content from the heating loss on 700 °C, at present of air. In my formal calculations the dry matter content of the cattle straw manure was 25%, the organic matter content was 19% by the literature's data, but the local data are about 21-22%, and 13-16%. These differences can decrease the recovered energy. I examined the earlier supplied, almost half year old dung first, and after it I changed them for fresh waste, it was in mezophil temperature range, in intermittent-duty. I let in the fermentor from the digested bio-manure about 5 volume % quantities to generate the fermentation, to accelerate the stabilization, the digestion. I chose the batch system, because to change the composition in the continuous system can produce more efficient exploitation of the equipments, the opportunities in the laboratory (for example the shortage of the fridge capacity) disables the permanent quantity of the components. The results of investigation I examine practically in two parts, because the long periods compressed produce misshapen figures. I controlled the methane content with Dräger X-am 7000 portable gas tester. Unfortunately I wasn't able to measure the gas production and methane content at the same time regularly, so I made charts and figures for the intensity of the gas releasing.

3. RESULT AND DISCUSSION

Results in connection with the development of the half industrial sized laboratory equipments

There was in the top level of the substratum a strong straw layer in the formal fermentors without automatic mixing, so I lift the mixer turbine higher and it had to size the axle for the power-driven mixing. I constructed the power-driven mixer to the fermentor in my invention, which produced the good efficiency of the biodegradation with one minute working duration eight times daily. Of course it needed more than two month retention time. Even so the emptying of the fermentor wasn't able to solve, the straw residue caused serious clogging up. It needs to check the possible clogging up of the gas tube too, because it can produce big pressures, destroys the cover of the fermentor.

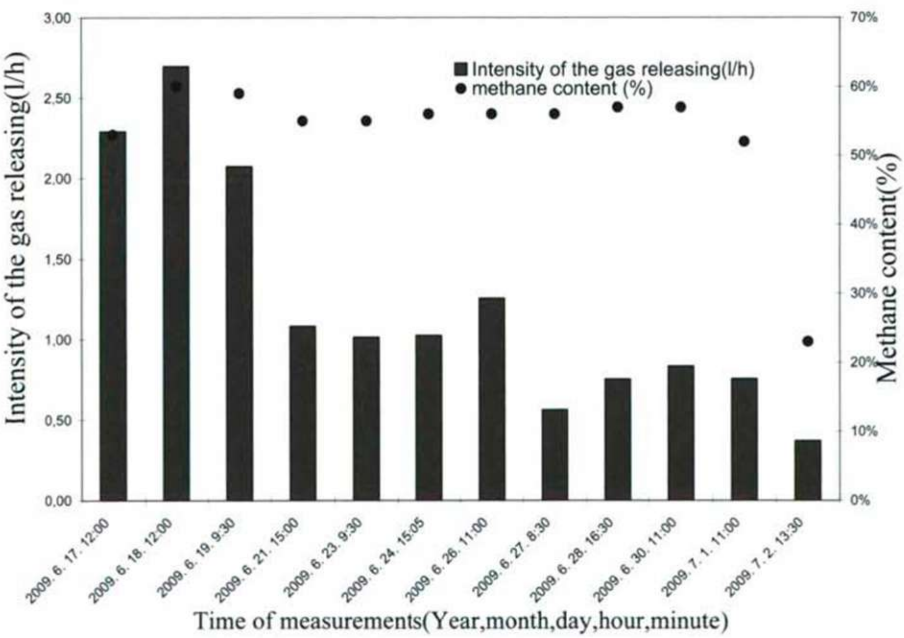

Fig.1. Data of the gas yield (1. sequence)

RESULTS IN CONNECTION WITH THE GAS YIELD

I calculated the theoretical gas production values with the input data in the *table 2.* based on the generally available literature coefficients. The measured data essentially differs from these, but the conditions are the same (38 °C). I diagnosed that the biodegradation ran in the ordinary way. The rapid increasing of the methane content is parallel with the changing of the intensity of the gassing, the decreasing doesn't follow it, quite well kept the relatively high, 50-60 % ratio *(Picture 1. Picture 2.)*. Comparing the data, the gas production of the manure which was stored in anaerobe condition for almost half of a year, is faster decreasing, the peak production was almost the 60% of the fresh one. In the aspect of methane content there is no significant difference between the two compositions. The energy balance is negative, because besides the 21 MJ/Nm^3=5,9 kWh/Nm^3 (60% methane) heating value I produced max. 0,1 m^3/d biogas, which energy content had approximately 0,59 kWh(2,1 MJ), with daily 8-9 kWh electrical energy used for the heating and the circulation of the heating water.

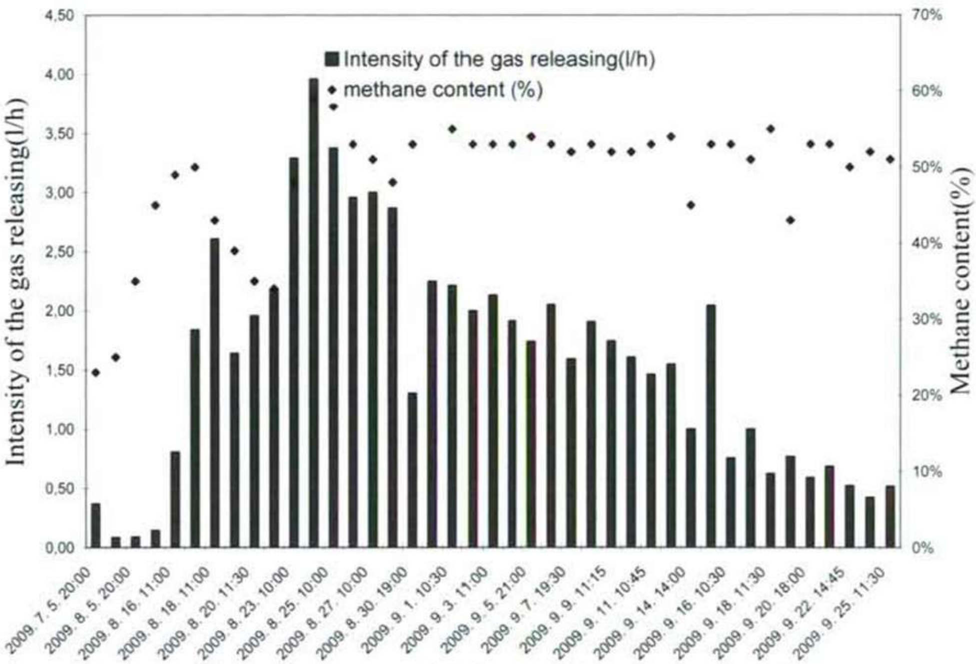

Fig.2. Data of the gas yield (2. sequence)

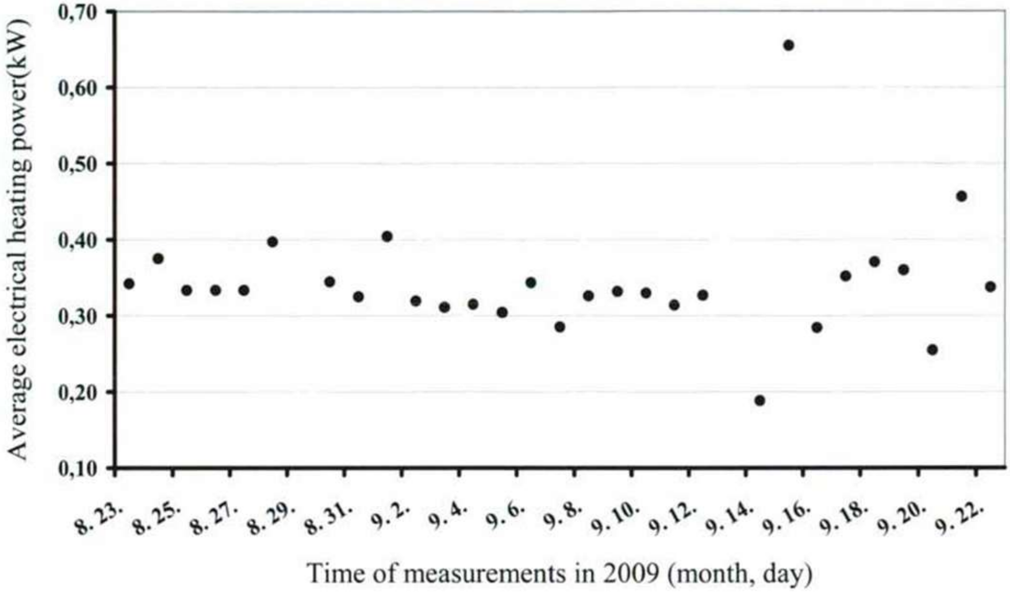

Fig.3. The energy consumption of the fermentation process (heating and heating water circulation)

Table 6.: Examination of the digested (bio-)manure

	Netto wet weight (g)	Nettó dry weight (g)	Netto inorg. Residue (g)	Org. matter weight (g)	OMC/DM C. (%)	DMC (%)	OMC (%)
Digested liquid phase	299,7	34,1	11,55	22,55	66	11,4	7,5
Digested solid phase	457,3	80,9	27	53,9	67	17,7	11,8
Mean						14,5	9,7

Dry matter content = DMC; Organic matter content –OMC;

I divided the digested material by the liquid content in two phases, I measured separately, and calculated the important data. The two phases represented the same masses inside the whole weight.*(Table 6.)*. In the view of degradation the dry matter content was decreased of the straw manures, the ratio of the organic matter content compared to the dry matter content didn't change.

4. CONCLUSIONS

The experiments justified the energy aimed anaerobic treatment of the organic waste of the pilot farm. The laboratory results didn't reach the theoretical values, because the gas realizing after the stabilization the most intensive, the available amount of energy can be dramatically less in consequence of the evaporation, resting of the dung. By the literature the presents of the methane decreases the methane production, that's why the process can be self controlled, but in my experiences it would be high pressures, that is in the case of imperfect gas removing it can destroy the techniques. That's why it is important the automatisation of the gas collection.

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